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Shen et al.

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(54) **METHOD FOR ANODIZING AND DYEING METALLIC ARTICLE**

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C25D 11/16	(2006.01)
C25D 11/24	(2006.01)
C25D 11/26	(2006.01)
C25D 11/30	(2006.01)

(52) **U.S. Cl.**

CPC ***C25D 11/02*** (2013.01); ***C25D 11/022*** (2013.01); ***C25D 11/024*** (2013.01); ***C25D 11/16*** (2013.01); ***C25D 11/243*** (2013.01); ***C25D 11/246*** (2013.01); ***C25D 11/26*** (2013.01); ***C25D 11/30*** (2013.01)

(58) **Field of Classification Search**

CPC C25D 11/02
USPC 205/95
See application file for complete search history.

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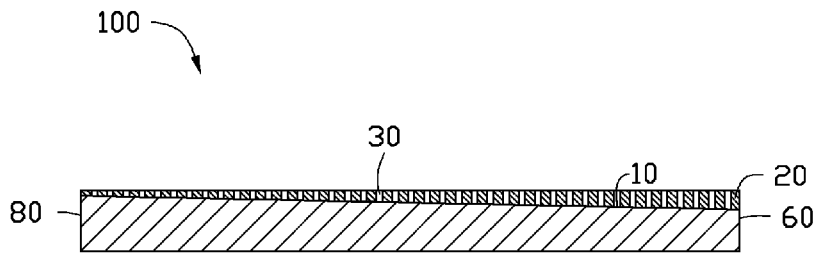
(57) **ABSTRACT**

A method for anodizing and dyeing a metallic article including a first dipped end, a second dipped end opposite to the first dipped end, and a decorated surface located between the first dipped end and the second dipped end, includes steps as follows: anodizing the metallic article to form an anodization layer on the decorated surface by an anodizing treatment, in which the anodization layer is porous with a number of holes, an immersion time of the decorated surface immersed in the electrolyte solution changes gradually from the first dipped end toward the second dipped end, and a depth of the plurality of holes of the anodization layer after the anodizing step thereby changes gradually from the first dipped end toward the second dipped end; and coloring the metallic article sealed in a dyeing treatment.

17 Claims, 7 Drawing Sheets



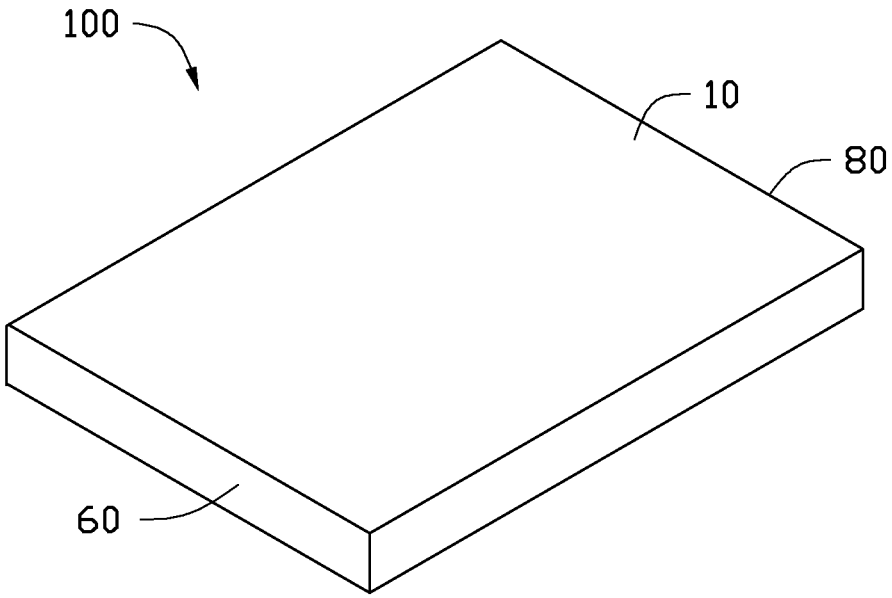


FIG. 1

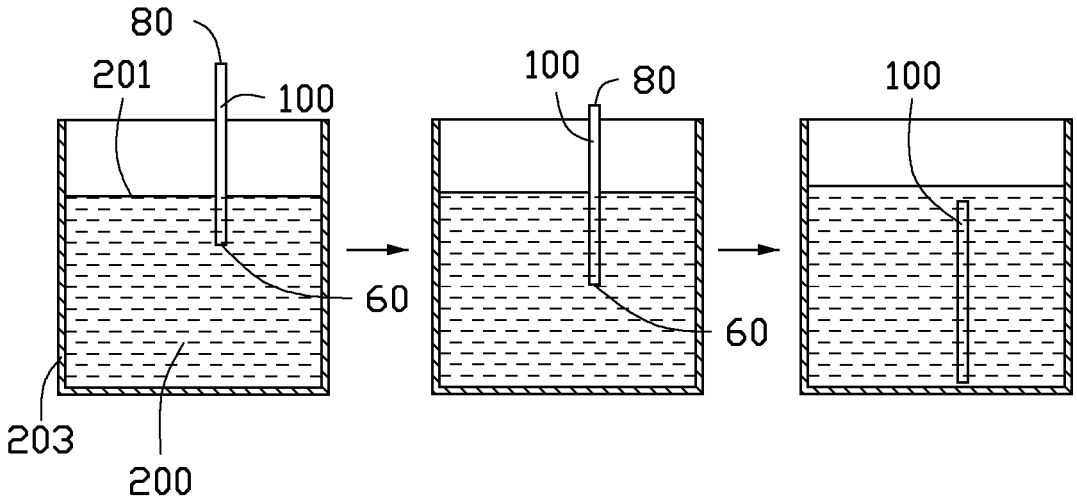


FIG. 2

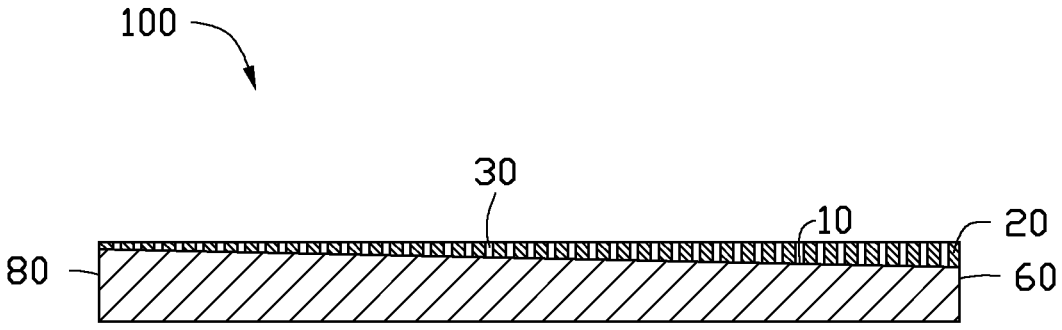


FIG. 3

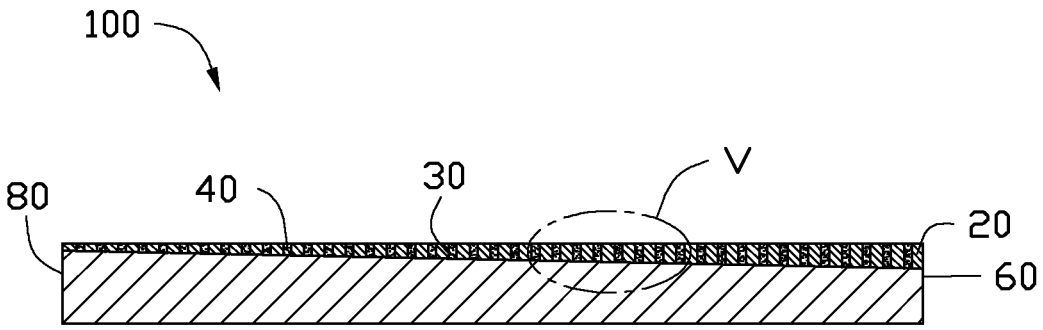


FIG. 4

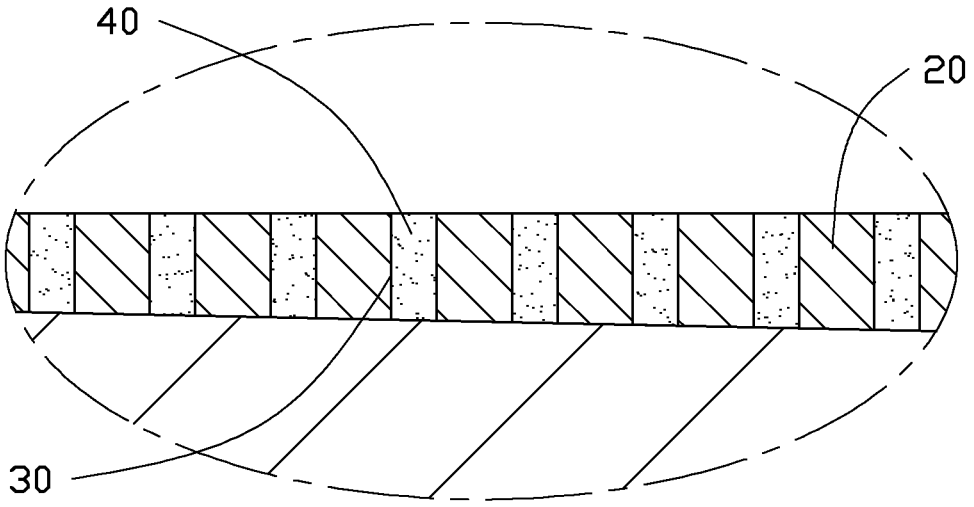


FIG. 5

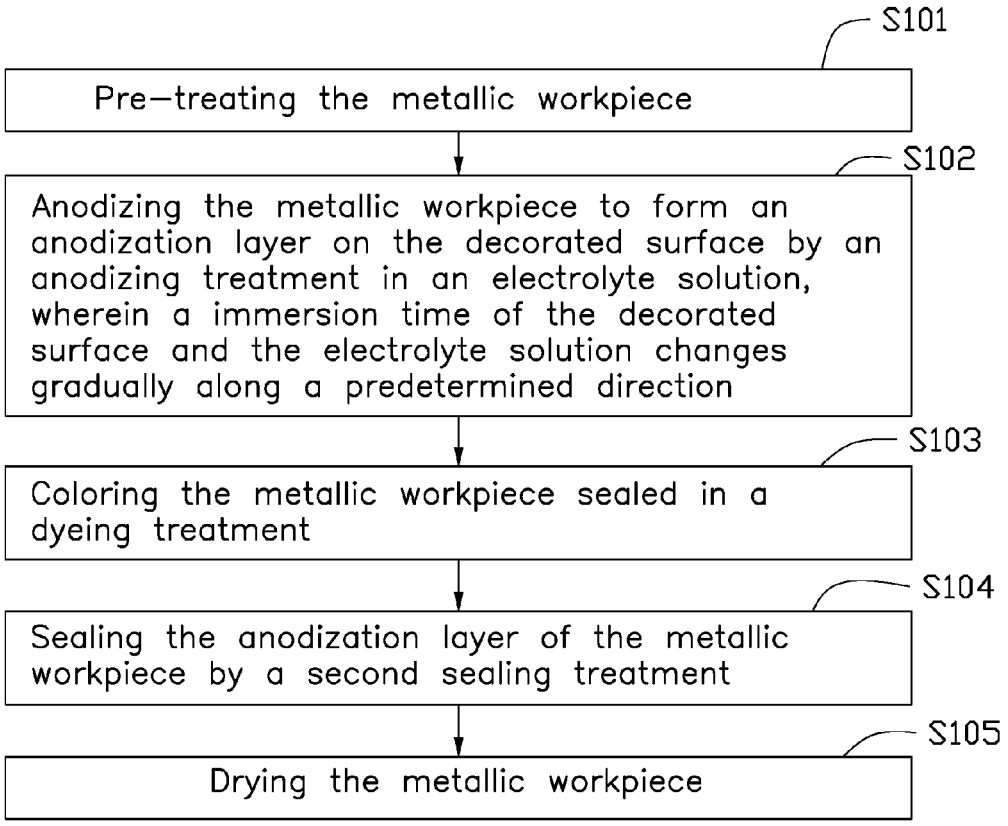

S101
Pre—treating the metallic workpiece
S102
Anodizing the metallic workpiece to form an anodization layer on the decorated surface by an anodizing treatment in an electrolyte solution, wherein a immersion time of the decorated surface and the electrolyte solution changes gradually along a predetermined direction
S103
Coloring the metallic workpiece sealed in a dyeing treatment
S104
Sealing the anodization layer of the metallic workpiece by a second sealing treatment
S105
Drying the metallic workpiece

FIG. 6

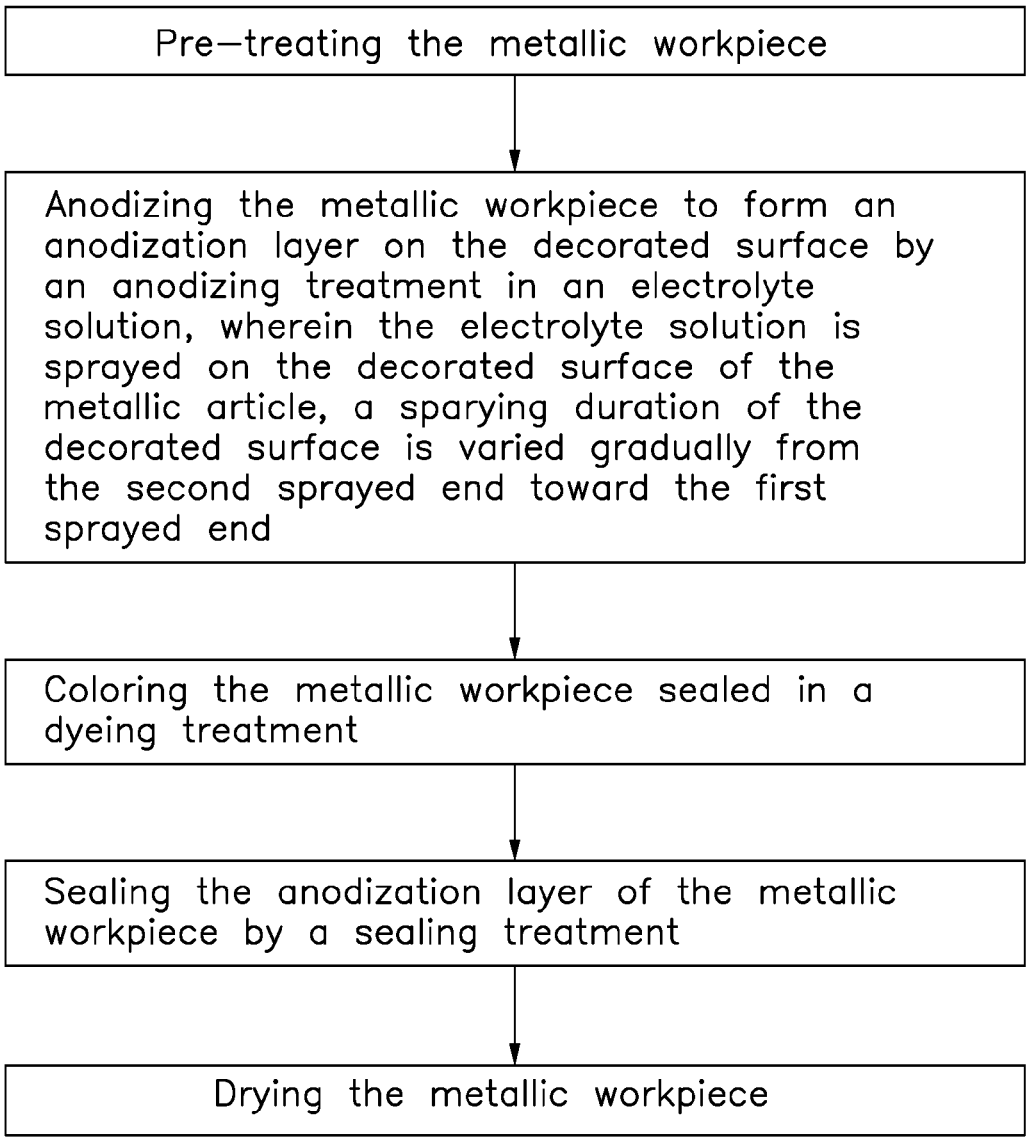

Pre—treating the metallic workpiece
Anodizing the metallic workpiece to form an anodization layer on the decorated surface by an anodizing treatment in an electrolyte solution, wherein the electrolyte solution is sprayed on the decorated surface of the metallic article, a sparying duration of the decorated surface is varied gradually from the second sprayed end toward the first sprayed end
Coloring the metallic workpiece sealed in a dyeing treatment
Sealing the anodization layer of the metallic workpiece by a sealing treatment
Drying the metallic workpiece

FIG. 7

METHOD FOR ANODIZING AND DYEING METALLIC ARTICLE

BACKGROUND

1. Technical Field

The present disclosure generally relates to methods for anodizing and dyeing metallic articles.

2. Description of Related Art

Metallic articles, such as articles made of aluminum/aluminum alloy, magnesium/magnesium alloy, and titanium/titanium alloy, are often anodized for protection, and then dyed or painted for achieving surface appearance requirements. However, this method is able to only provide an uniform singular monochromic color scheme and appearance.

Therefore, there is room for improvement within the art.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the disclosure can be better understood with reference to the following drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Moreover, in the drawings like reference numerals designate corresponding parts throughout the several views. Wherever possible, the same reference numerals are used throughout the drawings to refer to the same or like elements of an embodiment.

FIG. **1** shows an isometric view of a workpiece to be anodized and dyed of a first or second embodiment.

FIG. **2** shows an anodizing treatment step for the workpiece of FIG. **1**.

FIG. **3** shows a cross-sectional view of the workpiece of FIG. **1** after the anodizing treatment step.

FIG. **4** shows a cross-sectional view of the workpiece of FIG. **1** after a sealing treatment step.

FIG. **5** shows an enlarged view of a circled portion V in FIG. **4**.

FIG. **6** is a flowchart showing a first embodiment of a method for anodizing and dyeing the workpiece of FIG. **1**.

FIG. **7** is a flowchart showing a second embodiment of a method for anodizing and dyeing the workpiece of FIG. **1**.

DETAILED DESCRIPTION

FIG. **1** shows a workpiece **100** according to an illustrated embodiment to be anodized and dyed by a method for anodizing and dyeing a metallic article. In the illustrated embodiment, the workpiece **100** is a metallic article made of aluminum alloy, and is substantially rectangular plate-like in shape. The workpiece **100** includes a first dipped end **60**, a second dipped end **80** opposite to the first dipped end **60**, and a decorated surface **10** located between the first dipped end **60** and the second dipped end **80**. The decorated surface **10** of the workpiece **100** is to be dyed. In other embodiments, the workpiece **100** can be made of aluminum, magnesium, magnesium alloy, titanium, or titanium alloy.

Referring also to FIG. **6**, a first embodiment of a method for anodizing and dyeing the workpiece **100** of the illustrated embodiment of FIG. **1** is described as follows.

In step **S101**, the workpiece **100** is subjected to one or more pre-anodizing treatments, for smoothing and texturing the decorated surface **10**, and removing grease residues or a native oxide layer from the decorated surface **10**. The one or more pre-anodizing treatments may include one or more of polishing, texturing, degreasing, alkaline etching, and desmutting. Degreasing is performed using a weak alkaline solution, such as sodium pyrophosphate solution. Alkaline etching is performed using a strong alkaline solution, such as a sodium hydroxide solution. Desmutting is performed using a strong acid solution. Examples of polishing methods that may be used include chemical polishing or mechanical polishing. Examples of texturing that may be used include sandblasting or wiredrawing.

In step **S102**, the workpiece **100** is anodized in an electrolyte solution **200**, such that an anodization layer **20** is formed on the decorated surface **10**. The anodization layer **20** is porous by having a plurality of holes **30** therein. During the anodizing treatment, an immersion time of the decorated surface **10** in the electrolyte solution is varied gradually along a predetermined direction, such that the depth of the holes **30** gradually changes along the predetermined direction (referring to FIG. **3**). The anodizing treatment may be a direct current anodizing treatment, an alternating current anodizing treatment, or a pulse current anodizing treatment. In an illustrated embodiment, the direct current anodizing treatment is applied to the workpiece **100**. The workpiece **100** as an anode is electrically-connected to a positive electrode, and a sulfuric acid solution is used as the electrolyte solution **200**, such that the anodization layer **20** is formed on the decorated surface **10**. A thickness of the anodization layer **20** and a depth of the holes **30** can be changed by varying the amounts of anodization time (duration), current applied, and/or voltage applied. In other embodiments, the electrolyte solution may include nitrate ion, phosphate ion, chromate ion, or silicate ion.

In the illustrated embodiment, referring to FIGS. **2** and **3**, the decorated surface **10** is configured substantially perpendicular to a liquid level **201** of the electrolyte solution **200** in a container **203**, and the workpiece **100** is immersed in the electrolyte solution **200** at a predetermined velocity by a driving mechanism (not shown), and then taken out from the electrolyte solution **200** by the driving mechanism. Because the first dipped end **60** of the workpiece **100** enters the electrolyte solution **200** first and exits last, the anodization layer **20** will be thickest at the first dipped end **60** and gradually thinning toward the second dipped end **80**, with the result being that the depth of each of the holes **30** gradually increases going from the second dipped end **80** toward the first dipped end **60** of the workpiece **100**. The predetermined velocity of the workpiece **100** immersed in the electrolyte solution **200** can be maintained to be constant or varying. When the predetermined velocity of immersion of the workpiece **100** is kept or maintained constant, the depth of the holes **30** increases uniformly. On the other hand, if the predetermined velocity of immersion of the workpiece **100** changes or varies, the depth of the holes **30** increases non-uniformly.

In step **S103**, the workpiece **100** is colored by a dyeing treatment. In the dyeing treatment step, a coloring agent **40** enters and fills the holes **30**, respectively, to dye the decorated surface **10**. Because the depth of the holes **30** gradually changes, an amount of the coloring agent **40** that can be contained in the holes **30** thereby varies. Thus, the color of the coloring agent **40** filled in the holes **30** of the workpiece **100** appears in different shades (without noticeable color difference found in between adjacent regions of differing shades) by possessing a continuous color gradient, and the anodization layer **20** is colored with a gradual changing color or color gradient.

In step **S104**, the workpiece **100** is subjected to a sealing treatment. In the sealing treatment step, the workpiece **100** is immersed in a sealing solution to seal the holes **30**, such

that the anodization layer **20** has good or sufficient wear resistance. Sealing agents **40** in the sealing solution **200** can be nickel acetate, nickel sulfate, or cobalt sulfate.

In step S**105**, the workpiece **100** is heat dried.

In other embodiments, if the workpiece **100** is cleaned or a texturing effect is not needed, step S**101** can be omitted. Step S**104** can be omitted if a required wear resistance of the workpiece is low. Step S**105** can be omitted if desired, and the workpiece can be air dried instead.

Because the decorated surface **10** is not immersed in the electrolyte solution all at once, the depths of the holes **30** after the anodization treatment changes gradually from the first dipped end **60** toward the second dipped end **80** for each workpiece **100**, and the amount of the coloring agent **40** received in the holes **30** during the dyeing treatment varies gradually from the first dipped end **60** toward the second dipped end **80**. Thus, the color of the coloring agent **40** appears in different shades on the decorated surface **10** without noticeable color difference found in between adjacent portions, and the anodization layer **20** is colored with a gradual changing color or continuous color gradient. The above-described method for anodizing and dyeing a metallic article is easy to control, and thus is suitable for mass production.

In other embodiments, after pre-anodizing treatments, the decorated surface **10** may be anodized in the electrolyte solution **200** in other ways or via other techniques. For example, in a second embodiment (referring to FIG. **7**), the electrolyte solution **200** can be sprayed on the decorated surface **10** by a sprayer connected to the electrolyte solution **200**, and a spraying duration is controlled along a predetermined direction such as from a first sprayed end to a second sprayed end. Then, the workpiece **100** is colored by a dyeing treatment, sealed by a sealing treatment, and heat dried.

Depending on the embodiment, some of the steps being described may be removed or eliminated, while other steps may be added, and the sequence of steps may be changed. It is also to be understood that the description and the claims drawn to a method may include some indication in reference to certain steps. However, the indication used is only to be viewed for identification purposes and not as a suggestion as to an order for the steps.

It is to be understood, however, that even through numerous characteristics and advantages of the disclosure have been set forth in the foregoing description, together with details of the structure and function of the present disclosure, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the present disclosure to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A method for anodizing and dyeing a metallic article, the metallic article comprises a first dipped end, a second dipped end opposite to the first dipped end, and a decorated surface between the first dipped end and the second dipped end, the decorated surface of the metallic article being dyed, the method comprising steps as follows:

anodizing the metallic article to form an anodization layer on the decorated surface thereof by an anodizing treatment in an electrolyte solution, wherein the anodization layer is porous by having a plurality of holes therein, an immersion time of the decorated surface immersed in the electrolyte solution is varied gradually along a predetermined direction, and a depth of the plurality of holes of the anodization layer after the anodizing step thereby changes gradually along the predetermined direction; and

coloring the metallic article in a dyeing treatment; wherein a coloring agent enters and fills the plurality of holes, thereby an amount of the coloring agent contained in the holes varies.

2. The method for anodizing and dyeing a metallic article of claim **1**, wherein in the anodizing step, the first dipped end of the metallic article enters in the electrolyte solution first and exits last when the metallic article is immersed in the electrolyte solution, such that the depth of the plurality of holes of the anodization layer increases gradually from the second dipped end toward the first dipped end of the metallic article.

3. The method for anodizing and dyeing a metallic article of claim **2**, wherein a predetermined velocity of the metallic article immersing in the electrolyte solution is constant.

4. The method for anodizing and dyeing a metallic article of claim **1**, wherein the method further comprises a step of pre-treating the metallic article by a pre-anodizing treatment before the anodizing step.

5. The method for anodizing and dyeing a metallic article of claim **4**, wherein the pre-anodizing treatment comprises a polishing, texturing, degreasing, alkaline etching, or desmutting.

6. The method for anodizing and dyeing a metallic article of claim **1**, wherein the method further comprises a step of sealing the metallic article by a sealing treatment after the step of coloring the metallic article to seal the plurality of holes after the metallic article has been dyed.

7. The method for anodizing and dyeing a metallic article of claim **1**, wherein the metallic article is made of aluminum, aluminum alloy, magnesium, magnesium alloy, titanium, or titanium alloy.

8. The method for anodizing and dyeing a metallic article of claim **1**, wherein the anodizing treatment comprises a direct current anodizing treatment, an alternating current anodizing treatment, or a pulse current anodizing treatment.

9. The method for anodizing and dyeing a metallic article of claim **6**, wherein sealing agents of the sealing solution comprise nickel acetate, nickel sulfate, or cobalt sulfate.

10. A method for anodizing and dyeing a metallic article, the metallic article comprises a first dipped end, a second dipped end opposite to the first dipped end, and a decorated surface located between the first dipped end and the second dipped end, the decorated surface of the metallic article being dyed, the method comprising steps as follows:

anodizing the metallic article to form an anodization layer on the decorated surface by an anodizing treatment, wherein the anodization layer is porous by having a plurality of holes therein, the first dipped end of the metallic article enters in the electrolyte solution first and exits last when the metallic article is immersed in the electrolyte solution, such that the depth of the plurality of holes of the anodization layer increases gradually from the second dipped end toward the first dipped end; and

coloring the metallic article in a dyeing treatment; wherein a coloring agent enters and fills the plurality of holes, thereby an amount of the coloring agent contained in the holes varies.

11. The method for anodizing and dyeing a metallic article of claim **10**, wherein a predetermined velocity of the metallic article immersing in the electrolyte solution is constant.

12. The method for anodizing and dyeing a metallic article of claim **11**, wherein the method further comprises a

step of pre-treating the metallic article by a pre-anodizing treatment before the step of anodizing the metallic article.

13. The method for anodizing and dyeing a metallic article of claim **12**, wherein the pre-anodizing treatment comprises a polishing, texturing, degreasing, alkaline etching, or desmutting.

14. The method for anodizing and dyeing a metallic article of claim **11**, wherein the method further comprises a step of sealing the metallic article by a sealing treatment after the step of coloring the metallic article to seal the plurality of holes after the metallic article has been dyed.

15. The method for anodizing and dyeing a metallic article of claim **11**, wherein the metallic article is made of aluminum, aluminum alloy, magnesium, magnesium alloy, titanium, or titanium alloy.

16. The method for anodizing and dyeing a metallic article of claim **11**, wherein the anodizing treatment comprises a direct current anodizing treatment, an alternating current anodizing treatment, or a pulse current anodizing treatment.

17. A method for anodizing and dyeing a metallic article, the metallic article comprises a first sprayed end, a second sprayed end opposite to the first sprayed end, and a decorated surface between the first sprayed end and the second sprayed end, the decorated surface of the metallic article being dyed, the method comprising steps as follows:

anodizing the metallic article to form an anodization layer on the decorated surface thereof by an anodizing treatment in an electrolyte solution, wherein the anodization layer is porous by having a plurality of holes therein, the electrolyte solution is sprayed on the decorated surface of the metallic article, a spraying duration of the decorated surface is varied gradually from the second sprayed end toward the first sprayed end; and

coloring the metallic article in a dyeing treatment; wherein a coloring agent enters and fills the plurality of holes, thereby an amount of the coloring agent contained in the holes varies.

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